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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of: **Masanori AMANO** — Group Art Unit: **1772**

Serial Number: **10/765,899** — Examiner: **Catherine A. Simone**

Filed: **January 29, 2004** — Confirmation Number: **2604**

For: **LAYER FORMING RELIEF**

Attorney Docket Number: **032111**
Customer Number: **38834**

SUBMISSION OF APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

August 3, 2006

Sir:

Applicants submit herewith an Appeal Brief in the above-identified U.S. patent application.

Attached please find a check in the amount of $500.00 to cover the cost for the Appeal Brief. If any additional fees are due in connection with this submission, please charge Deposit Account No. 50-2866.

Respectfully submitted,

WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP

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RBC/jl

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPEAL BRIEF FOR THE APPELLANT

Ex parte Masanori AMANO et al. (Applicant)

LAYER FORMING RELIEF

Serial Number: **10/765,899**

Filed: **January 29, 2004**

Appeal No.:

Group Art Unit: **1772**

Examiner: **Catherine A. Simone**

Submitted by:
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Date: **August 3, 2006**

BRIEF ON APPEAL

(I) REAL PARTY IN INTEREST

The real party in interest is **KOMURA TECH CO., LTD.**, by an assignment recorded in the U. S. Patent and Trademark Office on **January 29, 2004** at Reel **014937**, Frame **0301**.

(II) RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellant, appellant's legal representative, or assignee that will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(III) STATUS OF CLAIMS

Claims 1-4 are pending in the application and are appealed. The appealed claims appear in the Claims Appendix.

(IV) STATUS OF AMENDMENTS

No amendments have been filed subsequent to the close of prosecution.

(V) SUMMARY OF THE CLAIMED SUBJECT MATTER

Claim 1 is directed to a layer forming relief R1 for transferring and printing an application fluid applied on printing convex portions 1 on a printing object, such as that illustrated in Figures 1, 2(a), and 2(b). The layer forming relief R1 comprises printing convex portions 1 formed as linear strips, adjoining printing convex portions 1 aligned to be parallel with each other with a prescribed space, and a plurality of micro-projections 2, formed into a truncated cone or in a cylinder. The micro-projections 2 are distributed on top faces of each of the printing convex portions 1 so as to form a groove 3 between adjoining micro-projections 2 for retaining the application fluid.

Claim 2 further characterizes the layer forming relief R1 such that the application fluid is an organic luminous substance. The height of the micro-projection 2 is in the range of 2 to 50 μm, the diameter of the top face of the micro-projection 2 is 5 μm or more, the space between the adjoining micro-projections 2 is 7 μm or more, and the number of the micro-projections 2 is in the range of 2 to 30 and are formed so as to be distributed in the width direction of the top face on the printing convex portion 1.

Claim 3 is directed at a layer forming relief R2 for transferring and printing an application fluid applied on top faces of printing convex portions 1 on a printing object, such as that illustrated in Figures 1, 7(a), and 7(b). The layer forming relief R2 comprises printing convex portions 1 formed as linear strips, adjoining printing convex portions 1 aligned to be parallel with each other with a prescribed space, and a plurality of projected micro-stripes 12 distributed on the

top faces of each of the printing convex portions 1 so as to form a groove 13 between adjoining micro-stripes 12 for retaining the application fluid. The cross section of the projected micro-stripes 12 in a direction perpendicular to a longitudinal direction is trapezoidal or rectangular.

Claim 4 further characterizes the layer forming relief R2 such that the application fluid is an organic luminous substance. The height of the projected micro-stripe 12 is in the range of 2 to 55 μm, the width of the top face of the projected micro-stripe 12 is 3.5 μm or more, the space between the adjoining projected micro-stripes 12 is 7 μm or more, and the number of the projected micro-stripes 12 is in the range of 2 to 33 and are formed so as to be distributed in the width direction of the top face on the printing convex portion 1.

(VI) ISSUES TO BE REVIEWED ON APPEAL

Whether claims 1-4 are unpatentable under 35 U.S.C. §103(a) over Hasagawa in view of Amano.

(VII) ARGUMENT

Discussion of the cited art

Hasegawa discloses a method for manufacturing an electro-optical device. The method utilizes a coating device 100 which applies a coating liquid 150 onto an anilox roller 130. Anilox roller 130 then applies the liquid onto letter press 110. On the letter press 110 are projections 111 and recesses 112. See Figure 5.

These projections 111 and recesses 112 are illustrated in detail in Figures 7(a) and 7(b). The projections 111 and recesses 112 extend in parallel with respect to each other, but in a direction oblique to the edge of the letterpress 110. On top of the projections 111, a mesh 119 is formed. This mesh 119 consists of smaller projections which extend the length of projections 111. These smaller projections are triangular in cross-section.

Amano discloses a resin relief printing plate for forming a thin film. As illustrated in Drawing 1(a), the printing plate is a resin relief printing plate 1, upon which printing relief portion 2 is disposed. Printing relief portion 2 includes a central region X, and a peripheral region Y, as illustrated in the cross-section of Drawing 1(b). Drawing 2 illustrates a close-up plan view of the printing relief portion 2, including the boundary between central region X and peripheral region Y. Both central region X and peripheral region Y include projections 3 and channels 4. As illustrated in Figures 3 and 4, the size of the projections 3 increases towards the peripheral region Y, and therefore the depth of the channels 4 decreases towards the peripheral region Y. As illustrated in Drawing 4, the resin printing plate of Amano is used in a similar fashion as that of Hasagawa.

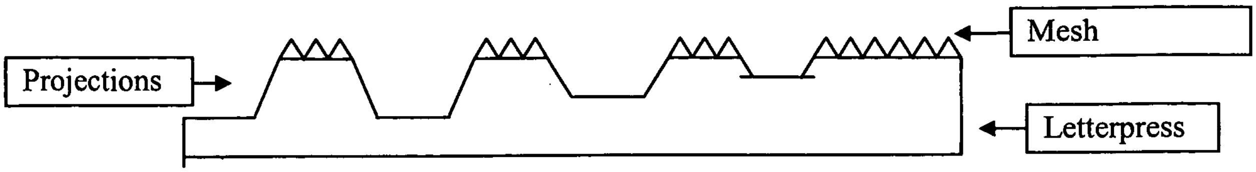
<u>Claims 1-4 are not unpatentable under 35 U.S.C. §103(a) over Hasagawa in view of Amano.</u>

In the Advisory Action dated May 19, 2006, the Examiner states that "Amano was merely cited for suggesting that it is old and well known in the analogous art to have a layer forming

relief including micro-projections formed into a truncated cone or cylinder." Page 3 of the Advisory Action dated May 19, 2006.

In response, Appellants respectfully argue that the Examiner has erred in the comparison of the components of Hasagawa and Amano. Hasagawa discloses a single letterpress 110, with a plurality of projections 111 formed thereon. Projections 111 have a mesh 119 of micro-projections formed thereon, the micro-projections being stripes which are triangular in cross-section. On the other hand, Amano discloses a single square-shaped printing relief portion 2 with series of truncated cone-shaped projections 3 formed thereon. No micro-projections are "distributed on top faces of" projections 3. The resin relief printing plate 1 is merely used in order to attach the printing relief portion 2 to the printing roll 11. Therefore, Appellants respectfully submit that the projections 3 of Amano are not analogous to the mesh 119 of Hasegawa, but are analogous to the projections 111 of Hasegawa, because they are formed on a top face of a single printing relief portion 2.

One having ordinary skill in the art would not have been motivated to combine the teachings of Amano and Hasegawa, since projections 111 of Hasegawa are formed in stripes, while the projections 3 of Amano are formed as truncated cones or cylinders. Further, even there were a motivation to form a printing plate with truncated cone or cylinder projections having a mesh on their top faces, the combination of Amano and Hasegawa would result in an apparatus with a cross-section as illustrated below:



Such a combination would not read on the present claims. The Examiner relies on Amano in order to teach that it would have been obvious to alter the mesh 119 which is triangular in cross section by replacing it with projections 3 which are truncated cones. However, Applicants respectfully submit that the Examiner's argument is misplaced, since the projections 3 and mesh 119 are not analogous to each other.

Therefore, Applicants respectfully submit that the combination of references does not disclose or suggest microstripes "distributed on the top faces of each of the printing convex portions" and which have a cross section which is "trapezoidal or rectangular," as required by claims 3 and 4.

Additionally, Appellants note that claims 1 and 2 recite micro-projections in the form of a "truncated cone or in a cylinder." As illustrated above, a combination of Hasagawa and Amano would retain the mesh 119 which extends the entire length of the projections 111. Since the mesh 119 extends along the projection 111, it is formed as stripes having a triangular cross-section, not as truncated cones or cylinders. Thus, the combination of references additionally does not disclose or suggest micro-projections formed as a "truncated cone or cylinder" as recited by claims 1 and 2.

(VIII) CONCLUSION

For at least the foregoing reasons, the Examiner has failed to raise a prima facie rejection of the claims. The Honorable Board is respectfully requested to reverse the rejection of the Examiner.

If this paper is not timely filed, appellants hereby petition for an appropriate extension of time. The fee for any such extension may be charged to Deposit Account No. 50-2866, along with any other additional fees that may be required with respect to this paper.

Respectfully submitted,

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RBC/jl
Enclosure: Verified English language translation of Amano

(IX) CLAIMS APPENDIX

Claim 1. A layer forming relief for transferring and printing an application fluid applied on printing convex portions on a printing object, the layer forming relief comprising the printing convex portions formed as linear strips, adjoining printing convex portions aligned to be parallel with each other with a prescribed space, and a plurality of micro-projections, formed into a truncated cone or in a cylinder, distributed on top faces of each of the printing convex portions so as to form a groove between adjoining micro-projections for retaining the application fluid.

Claim 2. The layer forming relief according to Claim 1, wherein the application fluid is an organic luminous substance, and the height of the micro-projection is in the range of 2 to 50 μm, the diameter of the top face of the micro-projection is 5 μm or more, the space between the adjoining micro-projections is 7 μm or more, and the number of the micro-projections is in the range of 2 to 30 and is formed so as to be distributed in the width direction of the top face on the printing convex portion.

Claim 3. A layer forming relief for transferring and printing an application fluid applied on top faces of printing convex portions on a printing object, the layer forming relief comprising the printing convex portions formed as linear strips, adjoining printing convex portions aligned to be parallel with each other with a prescribed space, and a plurality of projected micro-stripes distributed on the top faces of each of the printing convex portions so as to form a groove

between adjoining micro-stripes for retaining the application fluid,

wherein a cross section of the projected micro-stripes in a direction perpendicular to a longitudinal direction is trapezoidal or rectangular.

Claim 4. The layer forming relief according to Claim 3, wherein the application fluid is an organic luminous substance, and the height of the projected micro-stripe is in the range of 2 to 55 μm, the width of the top face of the projected micro-stripe is 3.5 μm or more, the space between the adjoining projected micro-stripes is 7 μm or more, and the number of the projected micro-stripes is in the range of 2 to 33 and is formed so as to be distributed in the width direction of the top face on the printing convex portion.

(X) EVIDENCE APPENDIX

None Presented

(XI) <u>RELATED PROCEEDINGS APPENDIX</u>

None Presented

CERTIFICATE OF VERIFICATION

I, Yoshiko KITA

state that the attached document is a true and complete translation to the best of my knowledge of Japanese Patent Application No. 2002-293049.

Dated this 12th day of June, 2006

Signature of translator: Yoshiko Kita

P2002-293049A

[Title of the Invention]

RESIN RELIEF PRINTING PLATE FOR THIN FILM FORMATION

[Abstract]

[Subject] A resin relief printing plate for thin film formation is provided which prevents occurrence of a marginal phenomenon and ensures formation of an orientation film having an even thickness.

[Solution means] A resin relief printing plate 1 to be used for transferring a coating liquid applied on a printing relief portion 2 thereof onto an object by printing for thin film formation. The printing relief portion 2 has a multiplicity of minute projections 3 distributed on the entire surface thereof, and a recess 4 defined between the adjacent minute projections 3 for retaining the coating liquid. The minute projections 3 present in a center region X of the printing relief portion 2 are equidistantly arranged. The minute projections 3 are arranged at a higher distribution density in a peripheral region Y of the printing relief portion 2 than in the center region X. In addition, the minute projections 3 present in the peripheral region Y are arranged in such a manner that the proportion of an area occupied by the minute projections 3 progressively

increases toward an edge of the peripheral region Y.

[Claims]

[Claim 1] A resin relief printing plate to be used for transferring a coating liquid applied on a printing relief portion thereof onto an object by printing for thin film formation, the resin relief printing plate characterized in that: the printing relief portion has a multiplicity of minute projections distributed on the entire surface thereof and a recess defined between the adjacent minute projections for retaining the coating liquid; the minute projections present in a center region of the printing relief portion are equidistantly arranged; the minute projections are arranged at a higher distribution density in a peripheral region of the printing relief portion than in the center region; and the minute projections present in the peripheral region are arranged in such a manner that the proportion of an area occupied by the minute projections progressively increases toward an edge of the peripheral region.

[Claim 2] A resin relief printing plate for thin film formation as set forth in claim 1, wherein the ratio of the distribution density (Y) of the minute projections present in the peripheral region of the printing relief portion to the distribution density (X) of the minute

projections present in the center region of the printing relief portion is (Y)/(X)=1.2 to 2.5.

[Claim 3] A resin relief printing plate for thin film formation as set forth in claim 1 or 2, wherein the minute projections each have a truncated cone shape or a cylindrical shape, wherein the minute projections present in a portion of the peripheral region of the printing relief portion adjacent to the center region each have a diameter which is not less than 0.3 times and less than 1.5 times a diameter of the minute projections present in the center region of the printing relief portion, and the minute projections present in a portion of the peripheral region of the printing relief portion adjacent to the edge of the peripheral region each have a diameter which is not less than 1.5 times and less than 3.0 times the diameter of the minute projections present in the center region of the printing relief portion.

[Detailed Description of the Invention]

[0001] [Technical Field of the Invention]

The present invention relates to a resin relief printing plate for thin film formation, which ensures that an orientation film having an even thickness can be formed on an electrode formation surface of a substrate for liquid crystal display elements.

[0002] [Prior Art]

Resin relief printing plates are conventionally used for various printing methods. Particularly, a relief printing method using a resin relief printing plate has recently been employed for formation of an orientation film of an orientation layer by printing in production of a liquid crystal display device. More specifically, a resin relief printing plate prepared by using a photo-curable resin is generally used for forming an orientation film of a polyimide resin on a surface of a glass substrate by printing. The liquid crystal display device is produced by preparing two glass substrates each having an orientation film of the polyimide resin formed by the printing with the use of the resin relief printing plate, stacking the glass substrates with the polyimide resin orientation films being opposed to each other, and sealing a liquid crystal in a space defined between the polyimide resin orientation films.

[0003] The formation of the orientation film by the printing with the use of the resin relief printing plate is achieved, for example, by performing the following steps. First, a resin relief printing plate having a recess for evenly retaining a coating liquid on the entire surface of a printing relief portion thereof is prepared.

The recess is provided by arranging minute projections having the same size at an even distribution density on the surface of the printing relief portion. After the coating liquid of the polyimide resin is applied on the entire surface of the printing relief portion and retained on the surface of the printing relief portion, the coating liquid is transferred onto the glass substrate. After the transfer, the coating liquid is dried for removal of a solvent and fired. Thus, the polyimide resin orientation film is formed on the glass substrate as having a size conforming to the size of the surface of the printing relief portion.

[0004] The polyimide resin orientation film thus formed on the glass substrate by the printing is required to have an even thickness. That is, the orientation film per se has recently been required to have an extremely high evenness to permit the liquid crystal display device to have a higher gradational display capability and a higher contrast. Therefore, if the polyimide resin orientation film has an uneven thickness or a slight variation in thickness, the liquid crystal display device suffers from gap unevenness, a variation in threshold voltage and display color inconsistency.

[0005] [Problems to be solved by the Invention]

The polyimide resin orientation film formed in the

aforesaid manner by the printing with the use of the resin relief printing plate with the minute projections evenly distributed on the printing relief portion has a thickness which is greater in a peripheral region thereof than in a center region thereof. This is because of the following reason. The transfer of the coating liquid onto the glass substrate is typically achieved by attaching the resin relief printing plate on the surface of a printing drum of a printer, supplying the coating liquid to the printing drum, and transferring the coating liquid onto the glass substrate at a predetermined biasing pressure at a predetermined rotation speed. Therefore, a part of the coating liquid retained in a center region of the printing relief portion of the resin relief printing plate is densely spread into a peripheral region by the rotation of the printing drum, so that a greater amount of the coating liquid stagnates in the peripheral region to form a liquid puddle. This results in a phenomenon such that a peripheral portion of the orientation film thus formed has a greater thickness (hereinafter referred to as "marginal phenomenon"). For example, an orientation film designed to have a thickness of 300Å to 900Å has a greater thickness on the order of 1200Å to 1800Å in the peripheral portion thereof. To eliminate such a drawback, various attempts have been conventionally made

in designing the pattern configuration of the printing relief plate and improving the printer by automatically adjusting the scanning speed of a printing stage and the concentration of the coating liquid. In reality, however, this problem is still unsolved.

[0006] In view of the foregoing, it is an object of the present invention to provide a resin relief printing plate for thin film formation, which suppresses the occurrence of the marginal phenomenon and ensures formation of an orientation film having an even thickness in a peripheral region as well as a center region of a printing relief portion thereof.

[0007] [Means for solving the problems]

To achieve the aforesaid object, an inventive resin relief printing plate to be used for transferring a coating liquid applied on a printing relief portion thereof onto an object by printing for thin film formation is constructed such that: the printing relief portion has a multiplicity of minute projections distributed on the entire surface thereof and a recess defined between the adjacent minute projections for retaining the coating liquid; the minute projections present in a center region of the printing relief portion are equidistantly arranged; the minute projections are arranged at a higher distribution density in a peripheral region of the

printing relief portion than in the center region; and the minute projections present in the peripheral region are arranged in such a manner that the proportion of an area occupied by the minute projections progressively increases toward an edge of the peripheral region.

[0008] The inventors of the present invention conducted a series of studies to provide a resin relief printing plate which suppresses the occurrence of the marginal phenomenon and ensures the formation of an orientation film having an even thickness. The inventors first conducted a study on a cause of the occurrence of the marginal phenomenon and, as a result, found that the marginal phenomenon occurs for the aforesaid reason. The inventors further conducted a study centering on a minute projection pattern to be formed on the printing relief portion of the resin relief printing plate for suppressing the formation of the coating liquid puddle in the peripheral region. As a result, the inventors found that it is possible to suppress the occurrence of the marginal phenomenon and ensure the formation of an orientation film having an even thickness by equidistantly arranging the minute projections present in the center region of the printing relief portion, arranging the minute projections at a higher distribution density in the peripheral region of the printing relief portion than

in the center region, and arranging the minute projections present in the peripheral region in such a manner that the proportion of the area occupied by the minute projections progressively increases toward the edge of the peripheral region. Thus, the present invention has been attained.

[0009] Where the ratio of a distribution density (Y) of the minute projections present in the peripheral region of the printing relief portion to a distribution density (X) of the minute projections present in the center region of the printing relief portion is in a particular range, it is possible to further suppress the occurrence of the marginal phenomenon and ensure the formation of the even thickness orientation film.

[0010] Where the minute projections each have a truncated cone shape or a cylindrical shape and the diameter ratio of the minute projections present in a portion of the peripheral region of the printing relief portion adjacent to the center region to the minute projections present in the center region of the printing relief portion and the diameter ratio of the minute projections present in a portion of the peripheral region of the printing relief portion adjacent to the edge of the peripheral region to the minute projections present in the center region of the printing relief portion are each in a particular

range, it is possible to further suppress the occurrence of the marginal phenomenon and ensure the formation of the even thickness orientation film.

[0011] [Embodiments of the Invention]

The embodiments of the present invention will hereinafter be described in detail.

[0012] An exemplary resin relief printing plate for thin film formation according to the present invention will be described. As shown in Figs. 1, the resin relief printing plate 1 has a rectangular shape as a whole, and includes a printing relief portion 2 provided in a center portion thereof. As shown in Figs. 2 and 3, the printing relief portion 2 has a multiplicity of minute projections 3 distributed over the entire surface thereof, and a recess 4 defined between the adjacent minute projections 3 for retaining a coating liquid for formation of an orientation film. In a center region X of the printing relief portion 2, the minute projections 3 are equidistantly arranged. In a peripheral region Y of the printing relief portion 2, on the other hand, the minute projections 3 are arranged at a higher distribution density than in the center region X, and the proportion of an area occupied by the minute projections 3 progressively increases toward an edge of the peripheral region Y. The proportion of the area occupied by the minute projections 3 herein means the

ratio of the total area of the minute projections 3 to the total area of the minute projections and the recess 4 defined between the adjacent minute projections 3.

[0013] The inventive resin relief printing plate 1 for the thin film formation has the same shape, and is composed of the same material and used in the same manner as a conventional one. That is, the basic construction of the resin relief printing plate 1 is such that the printing relief portion 2 and a non-printing portion 2a which supports the printing relief portion 2 are formed by curing a photo-curable resin. The coating liquid is applied on the surface of the printing relief portion 2, and transferred onto an object by printing.

[0014] The plan shape of the printing relief portion 2 is properly determined, but is typically a generally rectangular shape. Where the printing relief portion 2 has a rectangular shape in the present invention, the peripheral region Y of the printing relief portion 2 is defined as four side edge portions of the rectangular shape.

[0015] The range of the peripheral region Y of the printing relief portion 2 is properly determined according to the overall size of the resin relief printing plate 1, but is typically a range having a width of about 0.1mm to several millimeters, preferably about 0.1mm to about 1mm

as measured from a peripheral edge of the printing relief portion 2. Although the peripheral region Y is illustrated on a greater scale than the center region X of the printing relief portion 2 in Fig. 1(a) which is a schematic plan view of the resin relief printing plate 1, the peripheral region Y actually has a very small area as compared with the center region X.

[0016] The distribution density of the minute projections 3 present in the peripheral region Y of the printing relief portion 2 is higher than the distribution density of the minute projections 3 present in the center region X. More specifically, the ratio of the distribution density (Y) of the minute projections 3 present in the peripheral region Y of the printing relief portion 2 to the distribution density (X) of the minute projections 3 present in the center region X of the printing relief portion 2 is preferably (Y)/(X)=1.2 to 2.5, more preferably (Y)/(X)=1.3 to 2.3. If the ratio (Y)/(X) is lower than 1.2, the effect of preventing the occurrence of the marginal phenomenon is reduced. If the ratio (Y)/(X) is higher than 2.5, the recess 4 between the minute projections 3 for retaining the coating liquid does not have a sufficient depth (as measured from surfaces of the minute projections 3). Therefore, no path is present for releasing an excess portion of the coating liquid

from the center portion of the printing relief portion 2 to the outside of the printing relief portion, so that the resulting orientation film tends to be defective.

[0017] In the peripheral region Y in which the minute projections 3 are arranged at a higher distribution density, the proportion of an area occupied by the minute projections 3 progressively increases toward an edge of the peripheral region Y. The expression "the proportion of the area occupied by the minute projections 3 progressively increases" means that the proportion of the occupied area increases stepwise from the proportion of the area occupied by the minute projections 3 in a portion of the peripheral region Y of the printing relief portion 2 adjacent to the center region X to the proportion of the area occupied by the minute projections 3 in a portion of the peripheral region Y adjacent to the edge of the peripheral region Y. The ratio of the occupied area proportion (α) in the portion of the peripheral region Y adjacent to the edge to the occupied area proportion (β) in the portion of the peripheral region Y of the printing relief portion 2 adjacent to the center region X is preferably $(\alpha)/(\beta)=1.1$ to 3.3.

[0018] In the present invention, the depth of the recess 4 provided in the printing relief portion 2 is not particularly limited, but may have a substantially

constant depth over the surface of the printing relief portion 2. In general, however, the depth of the recess 4 defined between the multiplicity of minute projections 3 is substantially constant in the center region X of the printing relief portion 2, and progressively decreases from the center region X toward the edge in the peripheral region Y.

[0019] The distances between the minute projections 3 and the depth of the recess 4 are not particularly limited, but properly determined, i.e., according to the thickness of the orientation film to be formed by transferring the coating liquid by printing. Where the thickness of the orientation film is about 300Å to about 1000Å, for example, the distances between the minute projections 3 are preferably in the range of about 0.03mm to about 0.1mm, and the depth of the recess 4 is preferably in the range of about 0.002mm to about 0.035mm.

[0020] The minute projections 3 generally each have a truncated cone shape or a cylindrical shape. The minute projections 3 present in the portion of the peripheral region Y of the printing relief portion 2 adjacent to the center region X preferably each have a diameter which is not less than 0.3 times and less than 1.5 times, more preferably not less than 0.9 times and less than 1.3 times, the diameter of the minute projections 3 present in the

center region X of the printing relief portion 2, and the minute projections 3 present in the portion of the peripheral region Y of the printing relief portion 2 adjacent to the edge of the peripheral region Y preferably each have a diameter which is not less than 1.5 times and less than 3.0 times, more preferably not less than 1.6 times and less than 2.4 times, the diameter of the minute projections 3 present in the center region X of the printing relief portion 2. When the orientation film is to be formed by printing by means of a printer with the use of the resin relief printing plate 1 with the diameters of the minute projections 3 thus set, the coating liquid can be effectively evenly spread in a predetermined direction over the entire printing relief portion without stagnation by a pressure exerted on the coating liquid by rotation of a printing drum of the printer.

[0021] The arrangement pattern of the minute projections 3 provided on the printing relief portion 2 is preferably such that the arrangement pattern of the minute projections 3 provided in the peripheral region Y forms an angle of 0 degree to 45 degrees, more preferably 0 degree to 30 degrees, with respect to the arrangement pattern of the minute projections 3 provided in the center region X.

[0022] The inventive resin relief printing plate for the

thin film formation is prepared, for example, in the following manner. First, a negative film is prepared which includes transparent portions for the minute projections and a black portion for the recess in a region thereof corresponding to the printing relief portion of the resin relief printing plate, and a black portion for a region (non-printing region) of the resin relief printing plate other than the printing relief portion. Then, a liquid photo-curable resin is applied to a predetermined thickness on the negative film to form a liquid photo-curable resin layer. After the formation of the layer, a transparent film (base film) is stacked on the liquid photo-curable resin layer, which is in turn irradiated with light through the transparent film thereby to be cured. Thus, a non-printing portion of the resin relief printing plate is formed. Subsequently, the resulting resin layer is irradiated with light through the negative film. Thus, the formation of the printing relief portion of the resin relief printing plate, the multiplicity of minute projections and the recess defined between the minute projections on the printing relief portion is achieved. An uncured portion of the resin is washed away, and the resulting resin layer is dried and further exposed to light (post light exposure). Thus, the resin relief printing plate is prepared.

[0023] The inventive relief printing plate for the thin film formation may further include a base film layer, an adhesive layer such as of a pressure-sensitive adhesive and a metal plate or a synthetic resin plate stacked in this order on a surface (rear surface) of the thus prepared resin relief printing plate opposite from the printing relief portion. The resin relief printing plate having such a construction is less susceptible to a cupping phenomenon (in which the peripheral region of the printing relief portion of the relief printing plate per se has a greater thickness than the center region), thereby effectively suppressing the occurrence of the marginal phenomenon.

[0024] Any of known liquid photo-curable resins may be used as the liquid photo-curable resin without limitation. Examples of the photo-curable resin include resins prepared by adding a photo-sensitizer and a heat stabilizer to an unsaturated polyester resin, polybutadiene or the like and resins prepared by adding a photo-sensitizer and a heat stabilizer to an unsaturated resin having an unsaturated group introduced into a prepolymer such as of acryl, urethane, epoxy or polyester. Further, the photo-curable resin is not limited to the aforesaid liquid resins, but may be in a solid form such as a plate form. Specific examples of the photo-curable

resin include APR (available from Asahi Kasei Corporation), AFP (available from Asahi Kasei Corporation) and TEBISTA (available from Teijin K.K.).

[0025] For the formation of the characteristic pattern of the minute projections on the printing relief portion of the inventive resin relief printing plate for the thin film formation, the arrangement of the transparent portions for the minute projections and the black portion for the recess in the negative film is properly adjusted. Thus, a desired pattern of the minute projections is formed. The preparation of the negative film is achieved, for example, by forming the desired pattern by means of an image setter (image processing apparatus) for film exposure.

[0026] With the use of the thus prepared resin relief printing plate for the thin film formation, the orientation film as a thin film is formed in the following manner. A coating liquid for the formation of the orientation film is applied to be retained on the printing relief portion of the resin relief printing plate, and then transferred onto an object. After the transfer of the coating liquid, the coating liquid is dried for removal of a solvent, and fired. Thus, the orientation film is formed on the object as having a size conforming to the size the surface of the printing relief portion.

[0027] The object onto which the coating liquid is to be transferred is not particularly limited, but may be any of known objects. Examples of the object include a glass plate, a metal foil, a metal plate, a plastic plate, a plastic sheet, a knit fabric, a woven fabric, a non-woven fabric and a paper sheet, among which the glass plate, the metal foil and the metal plate are preferably used because these are less liable to absorb the transferred coating liquid.

[0028] Examples of the present invention will hereinafter be described in conjunction with Comparative Examples.

[0029] [Examples 1 to 10 and Comparative Examples 1 to 11]

<u>Preparation of Resin Relief Printing Plates</u>

First, a 10-mm thick glass plate was prepared. A negative film was placed on the glass plate, and a liquid photo-curable resin (APR available from Asahi Kasei Corporation) was applied to a predetermined thickness on the negative film by means of a knife coater. Thereafter, a base film was placed on the surface of the liquid photo-curable resin. The liquid photo-curable resin was irradiated with light through the base film, and then through the negative film. Thus, a printing relief portion as well as a multiplicity of minute projections and a recess defined between the minute

projections were formed. In turn, an uncured portion of the resin was washed away, and the resulting resin was dried and further irradiated with light (post light exposure). Thus, a main body of a resin relief printing plate was prepared.

[0030] The negative film used for the preparation of the resin relief printing plate was prepared with the use of a film exposure image setter which is used in a common printer and the like. The negative film had a pattern which permits the minute projections to have a distribution density and an occupied area proportion as shown in Table 1.

[0031] Subsequently, a 0.15-μm thick aluminum plate was bonded onto a surface of the thus prepared main body of the resin relief printing plate opposite from the printing relief portion with the use of a pressure-sensitive adhesive agent (a polyacrylate adhesive having an adhesive thickness of 0.03mm) with a releasable paper. All the steps described above were performed at a higher temperature on the order of 50°C for the preparation of the resin relief printing plate.

[0032] [Table 1]

Table 1

	Center region of printing relief portion		Peripheral region of printing relief portion	
	Distribution density of minute projections *1	Proportion of area occupied by minute projections (%)	Distribution density of minute projections *1	Proportion of area occupied by minute projections (%) *2
Example				
1	300	45	500	55→65
2	300	45	400	55→65
3	500	60	700	80→95
4	300	45	360	55→65
5	300	45	570	55→65
6	500	60	600	80→95
7	500	60	650	80→95
8	500	60	950	80→95
9	400	50	700	60→85
10	400	50	900	85→95
Comparative Example				
1	300	45	300	45
2	300	45	300	15
3	300	45	300	75
4	300	45	200	45
5	300	45	200	75
6	300	45	200	45→15
7	300	45	500	45
8	300	45	500	80
9	300	45	400	80
10	500	60	500	60
11	500	60	300	80

*1: The number of minute projections per inch (25.4mm).

*2: In Examples 1 to 10, the proportion of the area occupied by the minute projections progressively increases to the edge of the peripheral region. In Comparative Example 6, the proportion of the area occupied by the minute projections progressively decreases toward the edge of the peripheral region.

[0033] A thin film was formed in a conventional manner with the use of each of resin relief printing plates thus prepared. That is, as shown in Fig. 4, a printing roll (printer drum) 11 with the resin relief printing plate 10 attached to the surface thereof was prepared, and an object (glass substrate) 13 was placed on a printing stage (platen) 12. Then, a nip pressure for pattern printing was adjusted, i.e., a gap between an ink roll 14 and the printing roll 11 was adjusted to be 0.1mm (press amount), and a gap between the printing roll 11 and the object 13 was adjusted to be 0.1mm. The ink roll 14 and the printing roll 11 each had a smoothness of ±0.003mm, and the surface of the object 13 had a smoothness of ±0.050mm. In Fig. 4, a reference numeral 15 denotes an ink supplying apparatus, and a reference numeral 16 denotes a doctor blade for scraping excess ink on the ink roll 14.

[0034] Under the aforesaid conditions, the coating liquid

retained on the resin relief printing plate 10 was transferred onto the glass substrate 13. Then, the coating liquid transferred onto the glass substrate 13 was fired at 500°C in an oxidation-reduction atmosphere for 30 minutes. Thus, a polyimide resin thin film layer was formed.

[0035] The thickness of a center region of the thin film and the thickness of an edge of a peripheral region of the thin film were measured by means of a surface roughness meter (Profiler P-1) available from Tencor Japan Ltd. The results are shown in Table 2. Further, the results were evaluated. In the evaluation, the results were rated as follows on the basis of the thickness of the edge of the peripheral region of the thin film layer. A resin relief printing plate which was very effective for suppression of the marginal phenomenon was rated excellent (◎), and a resin relief printing plate which was effective to some extent was rated good (○). Further, a resin relief printing plate which was ineffective was rated unacceptable (×).

[0036] [Table 2]

Table 2

	Center region of thin film	Edge of peripheral region of thin film	
	Film thickness (Å)	Film thickness (Å)	Evaluation
Example			
1	600-800	<500	◎
2	600-800	<700	○
3	600-800	<700	◎
4	600-800	<700	○
5	600-800	<500	◎
6	600-800	<700	○
7	600-800	<600	◎
8	600-800	<600	◎
9	600-800	<700	○
10	600-800	<600	◎
Comparative Example			
1	600-800	>1000	×
2	600-800	>1000	×
3	600-800	>1000	×
4	600-800	>1000	×
5	600-800	>1000	×
6	600-800	>1000	×
7	600-800	>1000	×
8	600-800	>1000	×
9	600-800	>1000	×
10	600-800	>1400	×
11	600-800	>1700	×

[0037] As can be understood from the results shown in Table 2, the resin relief printing plates of Examples were advantageous, because the film thickness on the edge of the peripheral region of the thin film was not greater than the film thickness in the center region of the thin film. Particularly, the resin relief printing plates in which the ratio of the distribution density (Y) of the minute projections in the peripheral region of the printing relief portion to the distribution density (X) of the minute projections in the center region of the printing relief portion was (Y)/(X)=1.3 to 2.3 were excellent. In Comparative Examples, on the contrary, the film thickness on the edge of the peripheral region of the thin film was greater than the film thickness in the center region of the thin film.

[0038] [Effects of the Invention]

In the inventive resin relief printing plate for the thin film formation, as described above, the minute projections are equidistantly arranged in the center region of the printing relief portion, and the minute projections are arranged at a higher distribution density in the peripheral region of the printing relief portion than in the center region. In addition, the proportion of the area occupied by the minute projections present in the peripheral region progressively increases toward

the edge of the peripheral region. Therefore, a thin film formed by using the resin relief printing plate has an even thickness with the occurrence of the marginal phenomenon being suppressed.

[0039] Where the ratio of the distribution density (Y) of the minute projections present in the peripheral region of the printing relief portion to the distribution density (X) of the minute projections present in the center region of the printing relief portion is in the particular range, it is possible to suppress the occurrence of the marginal phenomenon and ensure the formation of an orientation film having an even thickness.

[0040] Where the minute projections each have a truncated cone shape or a cylindrical shape and the diameter ratio of the minute projections present in the portion of the peripheral region of the printing relief portion adjacent to the center region to the minute projections present in the center region and the diameter ratio of the minute projections present in the portion of the peripheral region of the printing relief portion adjacent to the edge of the peripheral region to the minute projections present in the center region are each in the particular range, it is possible to further suppress the occurrence of the marginal phenomenon and ensures the formation of an orientation film having an even thickness.

[Brief Description of the Drawings]

Figs. 1(a) and 1(b) are a plan view and a side view, respectively, schematically illustrating an exemplary resin relief printing plate for thin film formation according to the present invention;

Fig. 2 is a plan view schematically illustrating a part of the resin relief printing plate for the thin film formation according to the present invention;

Fig. 3 is a sectional view schematically illustrating a part of the resin relief printing plate for the thin film formation according to the present invention; and

Fig. 4 is a perspective view illustrating a thin film formation process employing the resin relief printing plate.

[Description of Reference Characters]

1: Resin relief printing plate

2: Printing relief portion

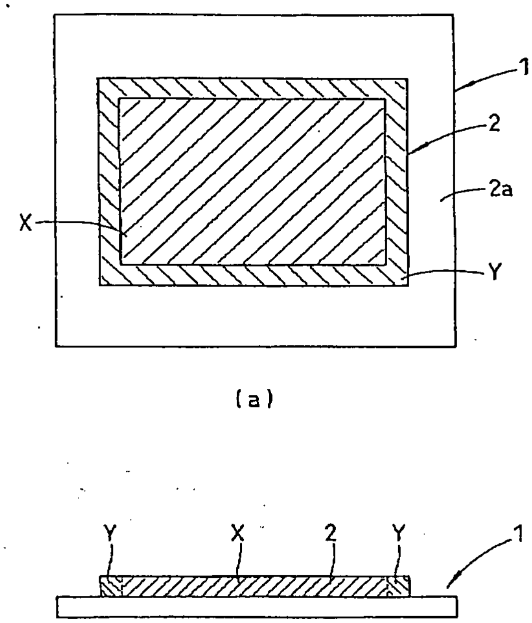
3: Minute projections

4: Recess

X: Center region

Y: Peripheral region

Fig. 1

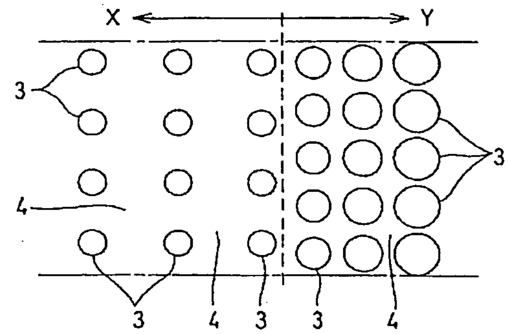


(a)

(b)

1: Resin relief printing plate
2: Printing relief portion
X: Center region
Y: Peripheral region

Fig. 2



3: Minute projections
4: Recess
X: Center region
Y: Peripheral region

Fig. 3

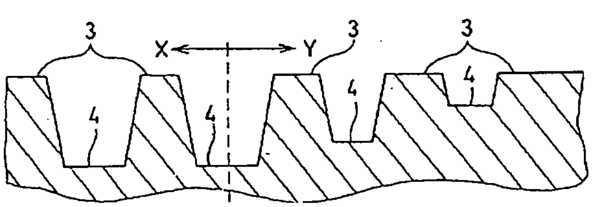


Fig. 4